On the Relationship Between Wool Quality and the Type and Concentration of Blood Potassium in Sheep

The occurrence and mode of inheritance of high (HK) and low (LK) blood potassium types in sheep have been the subject of several publications[1-6].

In the course of our studies on polymorphism in blood potassium type in sheep we examined 1059 blood samples from sheep distributed amongst 6 indigenous breeds (Malpura, Marwari, Chokla, Magra, Pugal and Nali), one exotic breed (Russian Merino) and one cross between Russian Merino and Malpura breeds. The animals used were all adults and of both sexes. Neither type nor the concentration of potassium in blood is affected by either sex or age[3].

The Russian Merino and the Russian Merino × Malpura crosses are maintained at one farm and each of the 6 other breeds is kept at separate farms in Rajasthan (India).

Blood potassium levels were determined according to a previously described method[2]. The foundation stock of Russian Merino sheep consisting of 5 rams and 22 ewes were all found to be LK. When these animals were mated, the surviving progeny – a total of 20 – was also found to be all LK. The Russian Merino rams when mated to 42 Malpura ewes, 22 of which were HK and 20 were LK, produced all LK lambs. It is apparent, therefore, that the Russian Merino is homozygous LK.

Mean potassium concentration and genotypes for Russian Merino, Malpura and Russian Merino × Malpura cross are given in Table I. The concentration of potassium in the whole blood is lowest in LK Russian Merino (K^LK^L), highest in HK Malpura (K^HK^H), and the value for LK Russian Merino × HK Malpura cross (K^LK^H), although not lying midway between those for LK Russian Merino (K^LK^L) and HK Malpura (K^HK^H), yet is significantly higher than that for LK Russian Merino (K^LK^L). It is clear that K^LK^L is not completely dominant over K^HK^H. When homozygous Russian Merino LK rams (K^LK^L) are mated to LK Malpura ewes (K^LK^L or K^LK^H) the concentration of whole blood potassium in the progeny (K^LK^L or K^LK^H) lies almost between those for the 2 parents, and is significantly different from each parental value. It indicates that the concentration of potassium in blood is controlled by minor genes in addition to the major genes which place the animal in high (HK) or low (LK) group. These results are in agreement with those of EVANS[7].

In the present study the wool quality of the breeds used varied from almost coarse to superfine and these between-breed differences in wool quality were associated with the frequency of LK gene (K^L). Results appearing in Table II indicate that as the frequency of K^L gene increases the average diameter of wool fibres decreases and that in Russian Merino, a superfine wool-producing breed of sheep, the frequency of K^L gene is 100%, whereas in Malpura and Pugal breeds of sheep producing coarse wool, the frequency of K^L is very low, varying from 12–18%. It seems pertinent, therefore, to conclude that an inter-relationship exists between the frequency of K^L gene and the quality of wool in a breed. This hypothesis regarding the association of the frequency of K^L gene with the fineness of wool gains support from the fact that fine to superfine wool-yielding breeds like the Rambouillet[4] in USA and the Merino[7] in Australia are almost 100% LK. When the published data on the frequency of K^L gene[6,8] and the average diameter of wool fibres[9] in 6 British breeds of sheep (Scottish Blackface, Romney Marsh, Suffolk Down, Hampshire Down, Southdown and Cheviot) were examined, there appeared to be a linear relationship between the 2 variables. This supports our hypothesis that the frequency of K^L gene is associated with the between-breed differences in fibre diameter; as the frequency rises the fibre diameter decreases.

The association between the frequency of K^L and the fineness of wool also apparently holds true when within-breed differences in wool quality are considered. In our study a flock of Marwari sheep was classified by expert

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Table I. Blood potassium type and potassium concentration in Russian Merino, Russian Merino × Malpura and Malpura sheep

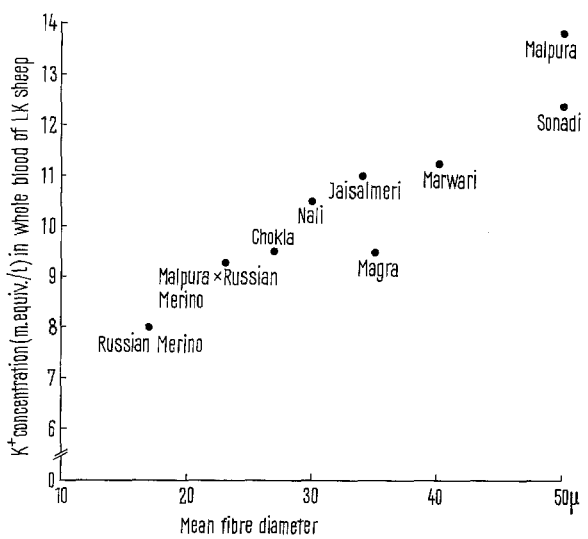
Breed	No. of animals	Potassium concentration (m. equiv.) in whole blood (Mean ± S.E.)	Potassium type	Genotype
Russian Merino ewes	42	8.31 ± 0.14	LK	K^LK^L
Russian Merino rams	5	7.81 ± 0.22	LK	K^LK^L
Malpura ewes	20	10.86 ± 0.29	LK	K^LK^L and K^HK^L mixed
Malpura ewes	22	27.81 ± 1.25	HK	K^HK^H
Russian Merino rams × LK Malpura ewes (ewes progeny)	20	8.95 ± 0.59	LK	K^LK^L and K^HK^L mixed
Russian Merino rams × HK Malpura ewes (ewes progeny)	22	9.46 ± 0.26	LK	K^HK^L

Table II. Relationship between K^L gene frequency and between-breed differences in wool quality

Breed	No. of animals	Frequency of K^L (%)	Wool quality		
			Grade	Fibre diameter, Mean	μ Range
Russian Merino	47	100	Superfine	17	16–18
Chokla	217	30	Fine to medium	27	20–35
Nali	182	29	Medium to fine	30	25–35
Magra	137	20	Medium	35	30–40
Marwari	113	15	Medium to coarse	40	35–45
Pugal	64	12	Medium to coarse	–	–
Malpura	199	18	Coarse	50	40–60

wool graders into 2 groups on the basis of wool worn by the animals, viz., (1) coarse to medium and (2) fine. The frequency of K^L gene in the group with fine wool was 0.35 whereas in the group with coarse to medium wool the frequency was only 0.17. Even in Australian Merino flocks, the frequency of K^L gene is 100% in fine and medium non-Peppin strains but in strong non-Peppin Merino, the frequency tends to decrease to 0.84[7].

In addition to the frequency of K^L gene, the actual concentration of K^+ in the blood is also associated with the between-breed differences in the fineness of wool, and this association is almost linear in LK stock, the type which has a higher frequency of K^L gene. Inspite of the relatively smaller number of LK animals in our breeds, a correlation as high as 0.909 ($P < 0.001$) has been obtained in this respect (Figure). The concentration of blood potassium in fine, medium and strong non-Peppin strains of Merino has been reported to be 8.01 ± 0.08, 8.11 ± 0.26 and 9.80 ± 0.17 m.equiv./l, respectively[7]. This also indicates that the concentration of blood K^+ decreases with improvement in the quality of wool. A similar relationship apparently exists in HK animals also, at least in our breeds, although the correlation has not been found to be statistically significant ($r = 0.670$; $P5\% = 0.754$).



Relationship between wool quality and blood potassium concentration in LK sheep.

Earlier workers[10,11] did not find any correlation between the blood potassium types and wool characteristics, possibly because their studies were either based on single breeds or on breeds which had little variation amongst them in their wool quality. Also, the variation in the concentration of blood potassium in different types of wool-bearing sheep did not attract their attention. These deficiencies of the earlier studies have been remedied in our experiments.

The important fact emerging from these studies is the immediate applicability of a biochemical parameter (viz., blood potassium type) for improved animal production. For developing a fine wool breed of sheep one should begin with a breed having a higher proportion of LK type animals, mate LK × LK, cull the HK sheep wearing relatively more hairy wool[12] and build a K^LK^L stock of fine to superfine wool. We feel confident that this approach will bring about a revolutionary change in the economic conditions of sheep farmers especially in the developing countries.

Résumé. Dans le sang des moutons, la fréquence des gènes du type LK est en relation linéaire inversément proportionelle à l'épaisseur de la fibre de laine. Il en va de même pour le degré de concentration du potassium. En se basant sur ces observations, les auteurs envisagent la possibilité d'améliorer la qualité de la laine ordinaire.

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